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THE PHILOSOPHICAL QUESTIONS OF CYBERNETICS

B. F. Semkov

There are many complex methodological and philosophical problems associated with the development of the new scientific discipline — cybernetics. In discussions which are carried out around cybernetics, these problems receive a great deal of attention. They evoke the deep interest of scientists of various specialties. For example, the theoretical conference of philosophical seminars of scientific institutes of the USSR Academy of Sciences (1-2 July) which was devoted to the philosophical questions of cybernetics, attracted more than 1,000 persons of whom more than 200 came from other cities of the country.

Academician A. I. Berg, on opening the conference, emphasized the great significance which the Party Program attaches to the development of cybernetics and the application of its attainments in industry, research, design and planning practices, planned economy, and in the field of computation, statistics, and management. Having set forth the problems which confront cybernetics, Berg called on the conference to concentrate their efforts on the correlation of accumulated achievements, their proper evaluation from the position of dialectic materialism, and the determination of ways to hasten the development of this

important new scientific trend. He directed attention to the need for an intimate association between the study of the philosophical questions of cybernetics and life, the practice of the development of science and technology.

A. A. Markov, in his report, gave a new definition of cybernetics free from the concepts of "control" and "information". Cybernetics, in his opinion, may be treated as a general theory of causal systems which studies them within an accuracy to isomorphism. In the cases considered by cybernetics, the matter reduces to a system consisting of a finite number of "nodes" each of which may be found in a finite number of states. Between the state of the nodes there are causal relations functioning in a time which is considered discrete and divided into "cycles". Together with "rigid" causal relations the author assumes the presence in the causal systems of "non-rigid" probability causal relations of non-Laplacian determinance.

Thus, the central problem of cybernetics, according to Markov is the problem of synthesis of causal systems, the construction from given elements of causal systems which respond in a fixed manner to external influences. Affiliated with this is the problem of control of causal systems, the proper organization of external influences on the available causal system in order to obtain a desired result.

According to the words of the author of the report, this definition does not claim to embrace all that at the present time is assumed to fall under the designation "cybernetics".

The question concerning the subject of cybernetics was also touched upon by A. A. Lyapunov and S. V. Yablonskiy who analyzed in detail the state of development of the theoretical aspects of cybernetics, indicated the level already reached in this area and revealed

the outlook for further investigation. Generalization and systematization of present achievements permitted the authors to draw up a detailed table of cybernetics problems illustrating excellently the idea of the generality of the laws of control in various natural phenomenon and in social living (biology, economy, technology, linguistics), and convincingly demonstrating the lack of validity of the attempts of opponents of cybernetics to limit its application to technology and to belittle its value as a science applicable to the most diverse branches of learning.

The primary attention of the conference was focused on the application of cybernetics not in engineering (the progress of which is already well known), but to natural phenomena and the human mind.

The reports of A. N. Leont'yeva and Ye. P. Krinchik were concerned precisely with this: "Certain Peculiarities of the Treatment of Information by Man", and of Ye. N. Sokolov: "Simulation of the Properties of Nervous System Stimulus". They indicated the level of theoretical and experimental studies on the application of the principles and methods of cybernetics in investigations of physiological problems and in the study of the psychic activity of man and his nervous system.

A. A. Lyapunov in the report, "Control Systems of Living Nature and General Understanding of Life Processes", very thoroughly revealed the essence of cybernetic control in biology. Having pointed out that it has as its problem the development of a complete understanding of vital phenomena originating from the idea of the structure of organisms and elementary vital acts, Lyapunov proposed his own definition of life as a highly stable state of matter which uses to develop preservation responses, information coded by the states of individual molecules. He pointed out as examples the wide possibilities of using this defini-

tion in the solution of very timely problems of modern biology. He pointed out that many modern successes of biochemistry and genetics are explained by the use of cyberentic methods. The decipherment of the biomechanism of the work of a gene, for instance, lay in the fact that a system was found for recoding information from deoxyribonucleic acid, its original carrier, to protein which is the primary carrier of information whose chemical activity determines the macroscopic property of a call. The nature of recoding of information from the language of deoxyribonucleic acid to the language of amino acids is by its very nature cybernetic.

The discussion of the problem of the "brain and machine", which previously had mainly an emotional character was successfully transferred to a scientific base. Experiments conducted during recent years provided a sufficient base for this. The report of V. M. Glushkov, "Thought and Cybernetics", was built upon just this point of view. The author focused attention on the discovery of the possibility of applying the methods of cybernetics in the perception of the regularities of thought and, above all, the possibility of simulating thought processes. Having shown that on the basis of the concept of an information converter used in cybernetics, this question is raised in an altogether new way, Glushkov came to the conclusion that any form of human thought can be modeled in an information plan in an artificially created cybernetic system even when they are restricted to systems constructed on already known principles of program control.

The question of the possibility of a machine being "smarter" than its creator must be considered dialectically, Glushkov pointed out. In certain areas of human mental activity, for instance in the planning of the national economy, such a possibility changed from a topic for

discussion to an important practical problem. This in part is related to scientific creativeness, especially to precise deductive sciences.

The dialectics of the process of teaching (assignment of a program) is such that surely the skill of the one learning to itself complete the program established in the machine does not follow from the skill of man to teach the machine something. The possibility for the machine to establish new facts independent of their creator has been revealed. This possibility was establihsed even in the simplest programs utilizing the operation of conditional transfer and expands even more both quantitatively and qualitatively in proportion to the complexity of the program.

Having established in a machine information concerning the basic regularities of the development of life (heredity, mutation, natural selection) and having omitted information concerning physical processes which take place on Earth, it is theoretically possible to force a machine (of course on a purely informational plane) to go through all the stages of evolution up to the rise and development of as high a form of conciousness as desired. A similar experiment, on a limited level, of course was conducted at the Computer Center of the Academy of Sciences of the Ukranian SSR and gave very interesting results.

In the future, said Glushkov in conclusion, a more and more significant part of the regularities of the world surrounding us will be percieved and utilized by man's automatic helpers, surpassing human conciousness. However the role of man in the processes of perception and thought will be all the more important.

Very interesting information in the development of the stand expressed by Glushkov has been stated in the reports of A. A. Fel'baum, "Learning Process in People and the Automaton", and of L. I. Land,

"Cybernetics and Certain Rationalization Methods of Learning".

A. I. Komogorov's report, "Life and Thought from the Point of View of Cybernetics", defends the view that the posibilities of simulating any complexly organized material systems on the basis of the achievements of current computer techniques are in no way limited and he asserted that the determination of life and thought must be free from arbitrary premises concerning the concrete physical nature of the physical processes underlying them. He came to the conclusion that simulation of a method of organizing a material system must be done in no other way than in the creation from other material elements of a new system possesing, in essential feature, the organization of a simulated system. Therefore, a sufficiently complete model of a living being should validly be called a living being and the model of a thinking being — a thinking being.

The author of the report together with Yu. Ofman studied the theory of discrete automatons with a constant number of simple elements and with a constant structure of the associations between them. Automatons of this type may bring about the simulation of automatons of the same nature or of selfconstructing systems, i.e., of analogous developments capable of altering their structure and attaching to themselves new elements. The question has been studied as to the existence of universal automatons of permanent construction within whose limits it is possible to simulate the evolution of any selfconstructing system until the number of elements in it exceeds the given number.

The problem of "the brain and the machine" was dealt with by N. G. Bruevich, A. I. Uyemov, I. B. Novik, S. M. Shalyutin, L. P. Bazhenov, V. S. Kazakovtsev, Sh. K. Abzishvili, and N. N. Borob'yev.

Discussion indicated that there is not yet a sufficient basis for a clear solution to this problem.

Consideration of the questions presented at the conference helped to separate the most important philosophical problems of cybernetics, to which effort must be directed in the future.

Of extreme value in this plan was the address of N. K. Anokhin who directed attention to the need for phiolosophical analysis of the question of general regularities in the mechanisms of various classes of phenomenon as a fundamental aspect of cybernetics. It is necessary to explain why the phenomena of so diverse a class, which we qualitatively separated in our world-view works, as it turned out, have a common pivot, a common architecture permitting their comparison, contrast and application of the regularities of one form of phenomena to another. This aspect of cybernetics was emphasized separately in the address of G. V. Linkovskiy.

Here it is appropriate to recall that V. I. Lenin gave great attention to question of common regularities in nature. In the work, "Materialism and Empirio-Criticism", focusing attention on the statement of Boltzmann concerning the fact that the same equations can solve the questions of hydrodynamics and express the theory of potentials and also concerning the fact that the theory of eddies in liquids and the theory of friction in gases reveal a striking analogy with the theory of electromagnetism, he wrote, "The harmony of nature is revealed 'in the remarkable correspondence' of differential equations pertaining to different areas of phenomena."

Cybernetics, which deals with common regularities, yields rich material for philosophical generalizations for treating the problem of the unity of nature. It is hardly possible to doubt that the attention

of scientists studying the philosophical problems of cybernetics must be riveted on this very question.

The answer to the question of the community between man and machine, which has been revealed by cybernetics, must be sought in just the direction of the disclosure of the unity of nature. The means of perception projected at the conference using the cybernetics of the regularities of the activity of the brain and the application of the results obtained for the creation of still more complete cybernetic systems will in the future ease philosophical generalizations in this direction. A direct relationship to the principles put forth above is found in the problem presented by I. B. Novik in his report, "The Nature of Information and Characteristics of Cybernetic Simulation", concerning the relation between the interesting approach to information processes and the property of reflection founded by Lenin in the work, "Materialism and Emperio-Criticism". The interesting approach to information, which considers it as an ordered reflection, leads to a number of consequences interesting in a methodological sense. With such an approach, an objective criterion is discovered for a comparison of the activity of the brain and the operation of a cybernetic machine. The philosophical principle of universal physical attributes of reflection, in the opinion of Novik, receives its natural-science confirmation and development in cybernetics.

The participants of the conference turned attention to the importance of further development with regard to the data of cybernetics, of such philisophical catagories as expediency, chance, and necessity, objectivity of information, catagories of difference and complexity.

As a result of the very interesting discussion of the conference a research plan was adopted concerning the philisophical questions of

cybernetics, having thus founded the beginning of more organized work in this direction.

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